

TRANSLATION (HM-613PCT-original)

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PROCESS AND SYSTEM FOR THE CONTINUOUS
PRODUCTION OF METAL STRIP

The invention pertains to a process for the continuous production of metal strip, preferably cold-rolled strip, and especially for the production of high-grade steel strip, where the strip to be produced is conducted in a transport direction through a system in which the strip is subjected to a rolling process, to a heating process, and to a chemical treatment. The invention also pertains to a system especially for implementing the process.

In the production of cold-rolled strip, especially high-grade steel strip, a metal strip passes through a production system, in which various processes are performed on the strip. The thickness of the strip is reduced by a rolling process. This can be followed by a heat treatment, by means of which the strip acquires special material properties. In addition, the strip must have a scale-free surface, for which reason it is passed through a pickling line, in which a chemical treatment is

applied to remove the scale.

For further processing, which can involve, for example, cold-rolling, the application of a metallic coating, or direct processing into an end product, the hot-rolled steel strip must have a scale-free surface. For this reason, the scale which has formed during the hot-rolling operation and the following cooling phase must be removed completely. This is usually done by a pickling process, during which the scale, which consists of various iron oxides (FeO , Fe_3O_4 , Fe_2O_3) or, in the case of stainless steels, of these iron oxides plus chromium-rich iron oxides, is removed at elevated temperatures by chemical reaction with one of various acids, e.g., hydrochloric acid, sulfuric acid, nitric acid, or mixed acids, depending on the grade of steel. Before the pickling step, an additional mechanical treatment by stretcher and roller leveling is usually required in the case of normal steel in order to break up the scale and thus to allow the acid to penetrate more quickly into the scale layer. For stainless, austenitic, and ferritic steels, which are much more difficult to pickle, an annealing treatment and a mechanical pre-descaling of the strip are conducted prior to the pickling process so that the surface can be pickled as

effectively as possible.

A process and a system of the general type in question is known from DE 100 22 045 C1. Here it is disclosed that a strip is guided through a pickling installation, which is both preceded and followed by a rolling unit. Downstream of the second rolling unit, the strip passes through an annealing furnace and then a pickling tank, in which the scale is removed from the surface of the strip. Before the strip, which is finished at this point, is coiled up, it can also be given a final treatment in a skin pass mill.

WO 00/37,189 and WO 00/37,190 disclose a system for the production of a metal strip, in which the thickness of the strip is first reduced in a multi-stand rolling mill. Then the strip passes through an annealing furnace; after that, the strip is guided through a pickling installation. Before the strip is coiled up, a rolling operation can be performed here, too, but it is used to reduce the thickness of the strip to only a very slight degree.

US 2001/0,037,667 A1 discloses a similar system for the production of metal strip. Here, however, the strip is not heated. The strip is merely passed through a rolling mill after

it has been descaled in a pickling line.

The previous processes suffer from the disadvantage that, in some cases, the rolling must be performed on scale-covered or only partially descaled surfaces. The rolling of surfaces of this kind leads to much greater wear on the rolls than that which occurs when the surface being rolled has been completely descaled. In addition, it is impossible to obtain the surface quality which is often demanded, which leads to the need for expensive refinishing treatments.

With respect to the economy of the process in question, it is also highly disadvantageous that the dimensions of the equipment installed downstream from the rolling mill, namely, the annealing furnace and the pickling line, must be adapted to the thickness of the strip, which has typically been reduced by the rolling process by 30-40%. Because the strip is now thinner but also longer, the annealing furnace and the pickling line must also be given a corresponding length, which increases the cost of the overall system.

The invention is therefore based on the task of creating a process and an associated system of the general type indicated above by means of which it is possible to avoid the

disadvantages cited, and where in particular it is possible to achieve higher productivity and economy in the production of strip. The surface quality of the finished strip is also to be improved.

With respect to the process, this task is accomplished according to the invention in that the rolling process is not conducted until after the strip has been heated and after it has been chemically treated.

As a result of this approach, the goal is achieved that the above-mentioned disadvantages do not appear when the three process steps, namely, the rolling of the strip to the desired thickness, the heat treatment of the strip by an annealing process, and the descaling of the strip by pickling, are performed in the production system. Because the strip is rolled from the original thickness to the reduced, final thickness only downstream of the annealing furnace and the pickling line, both the annealing furnace and the pickling line can be designed with smaller dimensions. In addition, the above-cited rolling process is carried out only after the surface of the strip has been completely descaled, which minimizes the wear on the rolls. As a result of the proposed sequence of processes, furthermore,

the quality of the strip surface is improved without the need for any further measures.

The heating of the strip, the chemical treatment of the strip, and the rolling process are preferably conducted in that order. The rolling process is preferably a tandem rolling process. In general, a "rolling process" is understood to involve a significant reduction in the thickness of the strip, preferably by at least 20%. As already mentioned above, the chemical treatment of the strip is preferably a pickling process.

The inventive system for the continuous production of a cold-rolled metal strip has an installation for heating, i.e., especially for the annealing, of the strip; an installation for chemically treating the strip; and an installation for rolling the strip. It is provided according to the invention that the installation for rolling the strip is installed downstream of the installation for heating the strip and the installation for chemically treating the strip, where the installation for rolling the strip has at least one tandem rolling mill. This consists of several roll stands, which can be of the 6-high type or of the Z-high type. Beyond this rolling installation,

nothing else is required to reduce the thickness of the strip.

To improve the surface quality, it is also possible to install a stretcher leveling unit between the installation for heating the strip (the annealing furnace) and the installation for chemically treating in the strip (the pickling line). A metal grain shot-blasting unit can also be installed between the annealing furnace and the pickling line.

It is also possible to install a trimmer unit downstream of the installation for chemically treating the strip to trim the lateral edges of the strip.

Providing the installation with at least one, preferably with three, loop towers makes it easier to keep the strip running as smoothly and uniformly as possible through the production system.

Depending on the amount of strip being produced, the previously explained production system can also be operated as a combination annealing and pickling line with integrated rolling mill (tandem mill) for hot-rolled and cold-rolled strip. To make this easier, a degreasing installation can be also be installed upstream of the installation for heating the strip, especially upstream of the entry-side loop tower.

The drawing shows an exemplary embodiment of the invention. The single figure is a schematic diagram of a system for the production of high-grade steel strip.

In the figure, a system 2 can be seen, in which a metal strip 1 (metal strand) is processed. The strip 1 is guided through the system 2 in the transport direction R, that is, from left to right in the figure, the goal being for the strip 1 to pass through continuously (i.e., to pass through at a more-or-less constant speed).

The strip 1 is supplied to the system 2 from an entry-side section 13 (not shown). That is, the strip 1 is unwrapped with an uncoiler (not shown) and fed into the system 2. Next in the transport direction R is a degreasing installation 12, in which the surface of the strip is cleaned. Then the strip 1 arrives in a loop tower 9 (entry-side storing unit), which is positioned underneath an installation 3 for heating the strip 1 (annealing furnace). The loop tower 9 ensures the continuous travel of the strip even when slight external disturbances occur in the infeed of the strip.

The strip 1 is subjected to a heat treatment in the annealing furnace 3. Then it arrives in a stretcher leveling

unit 6, in which the strip 1 is flattened. The stretcher leveling unit 6 is followed by a metal grain shot-blasting unit 7.

Downstream of the shot-blasting unit 7, an installation 4 for chemically treating the strip 1 is installed, namely, a pickling line, in which the strip 1 is guided through tanks filled with acid. The pickling process is able to remove the layer of scale on the surface of the strip 1, and the quality of the surface of the strip 1 can thus be improved.

Underneath the pickling line 4 is a loop tower 11 (intermediate storing unit). From here, the strip 1 passes onward to a trimmer unit 8, in which the sides of the strip are trimmed. From the edge trimmer 8, the strip 1 passes by way of another loop tower 10 (exit-side storing unit) to the installation 5 for rolling the strip 1. This installation 5 is designed as a tandem rolling mill. A succession of three rolling stands 5a, 5b, 5c, is provided, in which the strip 1 is rolled and its thickness thus reduced.

Downstream of the tandem rolling mill 5 is an exit section 14, which has a coiler (not shown), by means of which the finished strip 1 can be wound up into a coil.

As already mentioned, the tandem rolling mill 5 has three rolling stands 5a, 5b, 5c, which can be designed as a multi-roll cold-rolling mill in the form of a 6-high mill or a Z-high mill. Because the thickness reduction of the strip 1 occurs only at the end of the system 2 in the single installation 5 for rolling the strip 1, the strip 1 is still relatively thick upon arrival at the tandem rolling mill 5. That is, the strip still has the same thickness which it did on entering the system 2. This means that the design length of both the annealing furnace 3 and the pickling line 4 can be kept relatively short.

What is therefore obtained is a system 2 of relatively compact dimensions, which keeps down the investment costs for the system 2. Both the annealing furnace 3 and the pickling line 4 can be designed for the original thickness of the strip 1, i.e., the thickness at which the strip 1 enters the system 2.

At least for austenitic and simple ferritic materials, the thickness can be reduced without previous annealing. As a result, the maximum thickness reduction is decreased to no more than 30-40%.

The maximum thickness reduction per pass of the strip 1 through the system 2 is based only on the materials and the

capacity of the tandem rolling mill 5. There is no need to take into consideration the unannealed strip.

A rolling stand of the tandem rolling mill 5 can be designed so that the strip 1 can be given a skin pass after a final annealing.

Downstream from the system 2, the descaled and preferably already side-trimmed strip can be supplied continuously to a following installation (a hot-dip galvanizing plant, etc.) under uniform strip tension without intermediate storage. After leaving the following installation, the finished strip can then be coiled up alternately on two different reels and cut into sections with shears.

List of Reference Numbers

- 1 strip '(metal strand)
- 2 system
- 3 installation for heating the strip (annealing furnace)
- 4 installation for chemically treating the strip (pickling installation)
- 5 installation for rolling the strip (tandem rolling mill)
- 5a rolling stand
- 5b rolling stand
- 5c rolling stand
- 6 stretcher-leveling unit
- 7 metal grain shot-blasting unit
- 8 trimmer unit
- 9 loop tower (entry-side storage)
- 10 loop tower (exit-side storage)
- 11 loop tower (intermediate storage)
- 12 degreasing installation
- 13 entry section
- 14 exit section
- R transport direction